DOCUMENT RESUME

ED 110 240 RC 008 687

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TITLE Rural Electrification and Level of Living: Evaluation of Impact.
PUB DATE Aug 75
NOTE 26p.; Paper presented at annual meeting of the Rural Sociological Society, San Francisco, California, August 1975; Best copy available

EDRS PRICE MF-$0.76 HC-$1.95 PLUS POSTAGE
DESCRIPTORS Age; Correlation; Education; *Electricity; Heads of Households; *Hypothesis Testing; *Living Standards; *Rural Areas; Rural Development; *Surveys; Tables (Data)
IDENTIFIERS *Costa Rica

ABSTRACT

Utilizing an ex-post-facto experimental design, all occupied households located within the rural area of Canton San Carlos in Costa Rica (La Fortuna) were studied in August of 1972 for purposes of testing the hypothesis that electricity use is positively associated with level of living. Interviews with 452 heads of households (when possible) provided information on household members' age; sex; occupation and education; migration and propensity to migrate; mass media exposure; occupation and employment; land use and ownership; level of living; social participation and satisfaction with life situation. Based on data derived from the San Carlos Rural Electric Cooperative records and interviewer observations, electricity user categories were established as follows: (1) users (persons who had access to electricity and used it); (2) non-adopters (persons who had access to electricity but did not use it); and (3) inaccessibles (persons who were beyond the reach of power distribution lines). Controlling for size of household, education of household head, age of household head, and size of farm, Belcher's 1972 level of living scale was employed for analysis. Data supported the hypothesis, and it was suggested that consideration be given to the implications for developmental investment decisions and further research. (AC)

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RURAL ELECTRIFICATION AND LEVEL OF LIVING: EVALUATION OF IMPACT*

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Rural Sociological Society
Annual Meeting
San Francisco
August, 1975

RC 008687

We wish to express our sincere appreciation to the following individuals without whose collaboration this research could not have been conducted: Oscar Benavides of the Instituto Costarricense de Electricidad, Freddy Arroyo, Manager of the Cooperativa de Electrificacion Rural de San Carlos, and Victor Hugo Cespedes and Alvaro Vargas of the University of Costa Rica. Additonally, we are indebted to our collaborators on the larger study, James E. Ross and Galen Moses for valuable insights, helpful support, and good companionship.

ABSTRACT

This study examines the relationship between rural electrification and the level of living in a selected area of Costa Rica. It tests the hypothesis that electricity use is positively associated with level of living. An ex-post-facto experimental design was employed in which electricity users were compared with non-adopters (persons who had access to electricity but did not use it) and inaccessibles (persons who were beyond the reach of power distribution lines). Belcher's 1972 level of living scale was employed. The hypothesis is supported by the data even when the following variables are controlled: size of household, education of head of household, age of head of household and size of farm. These findings raise questions for further research and have implications for developmental investment decisions.

INTRODUCTION[1]

This study examines the relationship between rural electrification and the level of living in a selected area of Costa Rica. Although rural electrification has been the subject of numerous technical and other kinds of reports, no other studies of rural electrification from a sociological perspective are known to the authors.

The measurement and study of the level of living of rural populations has long occupied the attention of rural sociologists. Perhaps, better than any other measure, the level of living reflects the social well being and quality of life of rural populations. Level of living scales have been used for more than three decades to measure this characteristic which increasingly occupies the attention of planners. Sewell developed a widely used level-of-living scale for his 1940 study of Oklahoma farm families. Scales patterned after Sewell's have been used repeatedly. They proved to be a highly useful technique in that valid and reliable data can be gathered readily through surveys.

Until recently, however, level-of-living scales were both time-bound and culture-bound, in that they were mainly based on the possession of con-

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[1]This paper reports on a portion of the results obtained in a study conducted in Costa Rica on the social and economic impact of rural electrification under AID contract csd-3594. The conclusions are those of the authors and do not necessarily represent the viewpoints of the Agency for International Development.

sumer goods. Thus, for example, whereas ownership of a radio in 1930 in the United States had discriminatory value, currently, since ownership of this item is almost universal, it no longer does. Likewise, radio ownership would be inappropriate to use in a level-of-living scale comparing, for instance, Oklahoma farm families with Amish families because of the prohibition among the latter, for religious reasons, of possession of the item. Other items such as coffee grinders fall into disuse.

Belcher (1972) in discussing level of living scales emphasized that the functions satisfied in the household rather than possession of material items must be measured and developed a scale based on this concept. It measures level of living by assigning values to the manner in which universal functions related to a household and its occupants are performed, for instance, shelter, disposal of human waste, cleaning and lighting. Since these functions are performed to some degree in all households at all times, the scale does not suffer from the limitations mentioned above. It is the best technique available for assessing level of living between disparate social and national groups and changes over time.

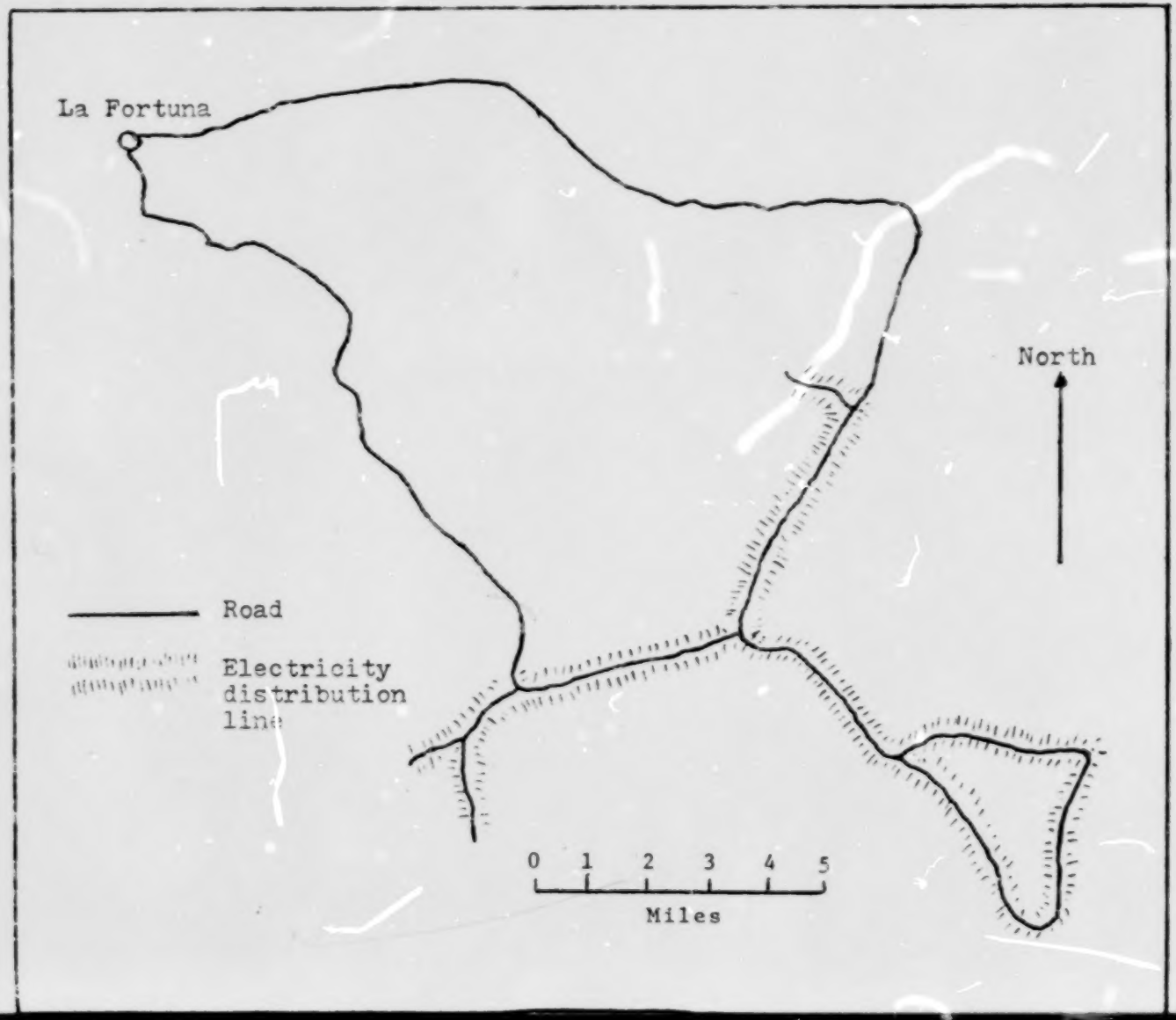
RESEARCH DESIGN AND DATA COLLECTION

Since we were limited to a one-time cross sectional measurement, an ex-post-facto experimental design was decided upon and an appropriate area for its application identified. The La Fortuna area of Canton San Carlos in Costa Rica was selected (Figure 1). It is highly rural. La Fortuna,

(Figure 1 about here)

Figure 1

Rural Flectrification Study Area, Costa Rica



the only town in the area, has about 500 inhabitants. The southeastern portion of the area is supplied with power generated by the Instituto Costarricense de Electricidad (Costa Rican Institute of Electricity) (ICE) and distributed by the Cooperativa de Electrificación Rural de San Carlos R. L. (San Carlos Rural Electric Cooperative) (COOPELESCA). This area has been electrified for three to four years and is, in effect, an experimental area. Its residents are defined below as USERS and NON-ADOPTERS of of electricity. The remaining northwestern portion of the study area is not served by a central electric distribution system. Its residents are defined below as INACCESSIBLES. Since the entire study area is homogeneous, residents of the northwestern portion are used as a control group in what is a naturally occurring experimental situation.

A group of trained interviewers from the Instituto de Investigaciones Economicas of the University of Costa Rica went into the field in August of 1972. Interviews were conducted in all occupied households located within the study area. Whenever possible, heads of households were interviewed. A total of 484 interviews were obtained of which 452 were usable. There was one refusal. Among the data obtained were characteristics of household members such as age, sex, occupation and education, migration and propensity to migrate, mass media exposure, occupation and employment, land use and ownership, level of living, social participation and satisfaction with life situation. The electricity user categories were based on data external to the interview schedule: COOPELESCA records and interviewer observation.

VARIABLES

Independent

The independent variable consists of three categories. Users of electricity supplied by the cooperative (USERS); persons who were within easy reach of the cooperative's lines but had not connected (NON-ADOPTERS); and persons beyond the reach of the cooperative's lines (INACCESSIBLES). USERS and NON-ADOPTERS, therefore, were located along the roads which were paralleled by electric lines in the southeastern portion of the study area. INACCESSIBLES were located along the roads in the northwestern portion of the study area which were not reached by the lines.

Dependent

The level-of-living scale (LEVEL) employed in this study is patterned after Belcher's. LEVEL is based on the responses to fourteen questions included in the survey schedule. These questions deal with shelter through the materials used in the construction of the dwelling and with the manner in which other basic functions are performed in the household. There were six possible responses to each question. Five of these were rank ordered ranging from low, indicating an absence or minimal means of fulfilling the function (assigned a value of one) to high for the most advanced method of satisfying the particular function (assigned a value of 5). The sixth response was a residual category in which answers that did not fit neatly into the other responses could be placed. These were later recoded to conform to the five-point classification. A zero was added as a sixth code. This was reserved for those cases when a particular function

such as cooking, for example, was not performed in or near the house of the respondent.

However, among the household functions included in LEVEL are some, for instance lighting, that can only be performed at the higher levels by employing electricity. Thus, for instance, the items under lighting were: 1. Candles, kerosene lamp, 2. Fuel oil lantern, 3. Gas or kerosene lantern, 4. Electric light bulbs or florescent tubes, 5. Electric lamps. Therefore, LEVEL is influenced by the use of electricity in that it is a prerequisite for attaining the highest scores. Consequently, an electricity-free level of living scale (LEVELNOE) was devised by eliminating five of the fourteen questions used in LEVEL which contain references to electricity.

Control

Size of household, education of the head of the household, age of the head of the household, and size of farm are used as control variables.

HYPOTHESIS

The impact of the use of electricity should be most clearly revealed by comparing those who are connected with the lines of the central source of power, the USERS, and those who, although they have had the opportunity, are not, the NON-ADOPTERS. The non-users who do not have an opportunity to use this source of power, the INACCESSIBLES, should have characteristics which differ from those of the USERS and NON-ADOPTERS. The INACCESSIBLES should have characteristics which approximate those which USERS and NON-ADOPTERS shared in common before they became differentiated by the adoption or non-adoption of the use of electricity. The INAC-

CESSIBLES, then, comprise a control group included in the research design. A single hypothesis is tested; that electricity use is positively associated with level of living.

ANALYSIS

Contingency Tables

The distribution of respondents according to the six categories of LEVEL for the total population approximates a bell-shaped curve (Table 1). Category three is the modal one embracing 23.2 percent of the respon-

(Table 1 about here)

dents. With the exception of category one, each of the groupings contains at least one-tenth of those interviewed. The level-of-living scale was cross-tabulated with the electric-use categories. The Chi-square test shows that the probability of this distribution occurring by chance is less than 0.001.

The USERS, those who use electricity supplied by COOPELESCA, are clustered toward the upper end of the level of living scale. Of the 185 USERS, only 40, or 21.6 percent, are not in the upper half of the LEVEL groupings. The INACCESSIBLES, those who are beyond the reach of the COOPELESCA distribution system, are concentrated in the lower middle range of LEVEL. Only 27.8 percent of the INACCESSIBLES are grouped in the upper three categories of LEVEL. The NON-ADOPTERS, those who could but have not availed themselves of the opportunity of utilizing COOPELESCA electricity, disproportionally fall into the lower

Table 1

Row Percentages and Number of Respondents
in Level of Living Scale (LEVEL) Categories
by Electric Use Categories

Electric-Use Categories	LEVEL Categories 1 (low)	2	3	4	5	6 (high)	Total	Means
USERS	0.0 (0)	6.5 (12)	15.1 (28)	23.3 (43)	30.8 (57)	24.3 (45)	100.0 (185)	4.5
INACCESSIBLES	11.2 (19)	29.6 (50)	31.4 (53)	18.9 (32)	8.9 (15)	0.0 (0)	100.0 (169)	2.8
NON-ADOPTERS	22.5 (22)	34.7 (34)	24.5 (24)	7.1 (7)	7.1 (7)	4.1 (4)	100.0 (98)	2.5
TOTAL	9.1 (41)	21.3 (96)	23.2 (105)	18.1 (82)	17.4 (79)	10.9 (49)	100.0 (452)	3.5

reaches of the level-of-living scale. Over half, 57.2 percent, of the NON-ADOPTERS are in the lowest two categories of LEVEL. It is thus clear that there is a positive association between the use of electricity and the level of living.

The distribution of the total population also resembles a bell-shaped curve according to LEVELNOE. The middle category is modal containing nearly one-third, 33.0 percent, of the respondents (Table 2). Only

(Table 2 about here)

slightly smaller is category two with 30.1 percent of the cases. The data from the electricity-free level-of-living scale were cross-tabulated with those for the electric-use categories. The Chi-Square test shows that the probability of the relationship between LEVELNOE and the electric-use categories occurring by chance approximates 0.001.

Certain characteristics of the various types of users and non-users are revealed in Table 2. USERS predominate in the upper-middle categories of LEVELNOE. Some 45.9 percent are classified as being in categories four and five. In comparison, the INACCESSIBLES are fairly evenly distributed between categories two and three. The former category contains 38.5 percent of the INACCESSIBLES: another 37.9 percent are placed in the latter class. The NON-ADOPTERS are clustered around the lower end of LEVELNOE. The modal category of these non-users is the second classification where 42.9 percent of the NON-ADOPTERS are placed. These tabulations are shown graphically in Figure 2. The positive association

Table 2

Row Percentages and Number of Respondents

in Electricity-free Level of Living Scale (LEVELNOE)

Categories by Electric Use Categories

Electric-Use Categories	LEVELNOE Categories 1 (low)	2	3	4	5 (high)	Total	Means
USERS	2.2 (4)	15.7 (29)	36.2 (67)	31.9 (59)	14.0 (26)	100.0 (185)	3.4
INACCESSIBLES	8.9 (15)	38.5 (65)	37.8 (64)	14.2 (24)	0.6 (1)	100.0 (169)	2.6
NON-ADOPTERS	29.6 (29)	42.8 (42)	18.4 (18)	8.2 (8)	1.0 (1)	100.0 (98)	2.1
TOTAL	10.6 (48)	30.1 (136)	33.0 (149)	20.1 (91)	6.2 (28)	100.0 (452)	2.8

(Figure 2 about here)

between electricity use and level of living persists, therefore, when electricity related items are deleted from the level of living scale.

Difference Between Means and Ratios Between Means

The relationships between the categories of users and non-users of electricity and level of living is similar whether using LEVEL or LEVELNOE. Using LEVELNOE, the USERS have the highest level of living as shown by their mean score of 3.4 (Table 2). The INACCESSIBLES occupy the median position and have a mean score of 2.6. The NON-ADOPTERS have, on an average, the lowest level of living as shown by their arithmetic mean of 2.1. The t-test scores for difference between means showing the level of significance between scores of the categories and combinations of categories of the electric-use characteristic are presented in Table 3.

(Table 3 about here)

The association between the use of electricity and level of living is dramatically shown by comparing the LEVELNOE scores of the USERS and NON-ADOPTERS by computing ratios of the percentages of USERS to NON-ADOPTERS by category of LEVELNOE (Table 4). The importance of USERS

(Table 4 about here)

vis-a-vis NON-ADOPTERS increases with rises in the value of LEVELNOE demonstrating that the USERS are highly concentrated in the middle and upper ranges of the scale and NON-ADOPTERS in the lower part of it.

Figure 2

Percentages of Users, INACCESSIBLES, and NON-ADOPTERS by Categories of Electricity-free Level of Living Scale (LEVELNOE), Costa Rica

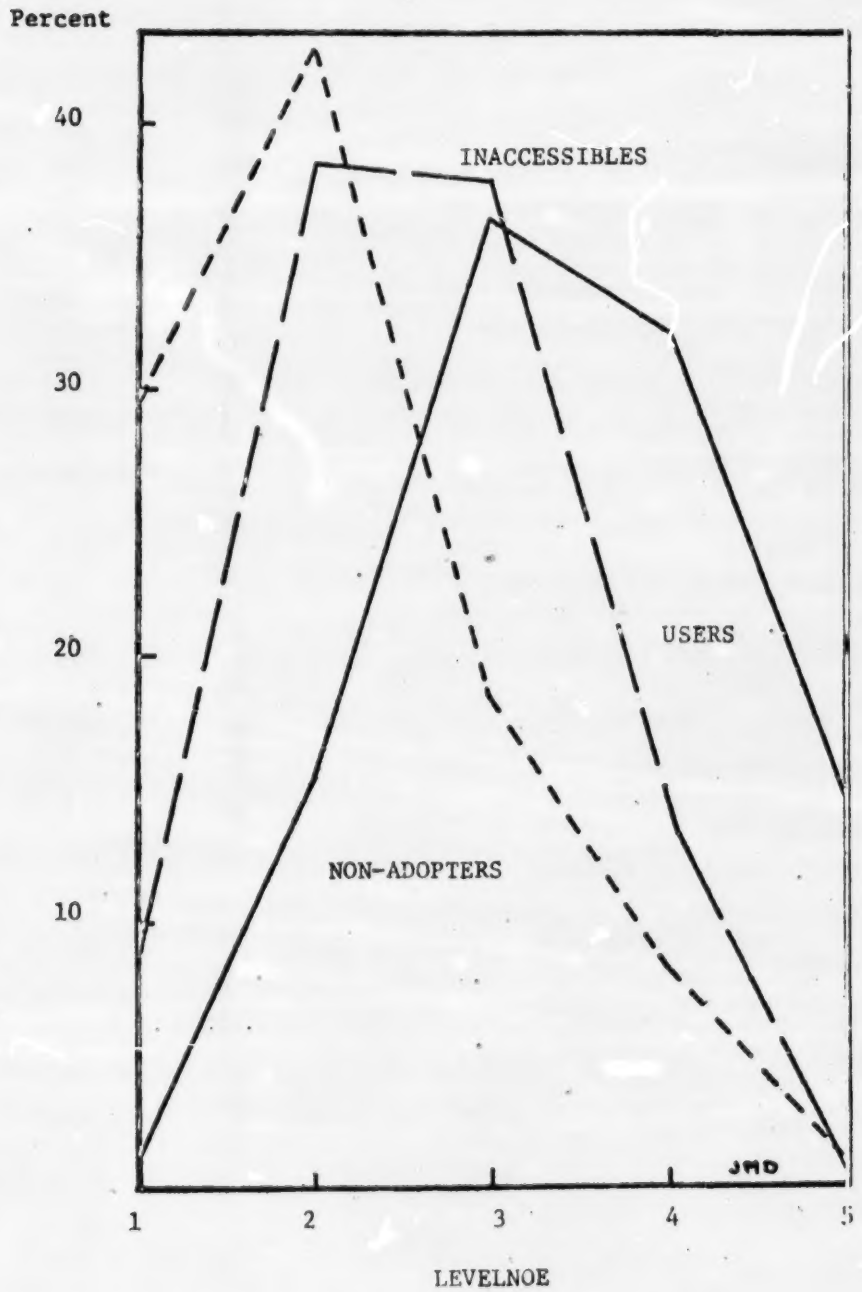


Table 3

Scores of T-Tests for Difference between Arithmetic Means and Levels of Significance for Categories and Combinations of Categories of the Electric-Use Characteristic by Electricity-free Level-of-Living Scale (LEVELNOE)

Electric-Use Categories	T-Test Score	Level of Significance for Two-tailed Test
USERS to NON-ADOPTERS	10.85	0.001
USERS to INACCESSIBLES	8.18	0.001
INACCESSIBLES to NON-ADOPTERS	4.49	0.001
USERS to NON-ADOPTERS and INACCESSIBLES	10.95	0.001

Table 4

Percentages of USERS and NON-ADOPTERS by Categories of Electricity-free Level-of-Living Scale (LEVELNOE) and Ratios of Percentages of USERS to NON-ADOPTERS

	LEVELNOE Categories					
	1	2	3	4	5	Total
USERS (percentages)	2.2	15.7	36.2	31.9	14.0	100.0
NON-ADOPTERS (percentages	29.6	42.8	18.4	8.2	1.0	100.0
Ratio of percentages of USERS to NON-ADOPTERS	0.074	0.367	1.967	3.890	14.000	

In summary, the evidence supports the proposition that there is a direct association between level of living and the use of electricity. Although both users and non-users of electricity are found in all of the categories of level of living, USERS are highly concentrated in the higher categories, non-users in the lower. The grouping in the lower levels of LEVELNOE is more pronounced for NON-ADOPTERS than is the case for INACCESSIBLES.

Control of Variables

The existence of an association between two variables does not necessarily demonstrate causality. Other factors may be expected either to cause or to vary concomitantly with changes in the level of living. Among these are the size of the household, education and age of the head of the household, and size of farm. The relationships between each of these characteristics and the level of living are now examined, with the new variables being used as controls, in the analysis which follows. Attention is paid to the variations within each of the factors according to the use or non-use of electricity in an attempt to evaluate the parameters of the associations found between the use of electricity and level of living.

It could be expected that as the number of people living in a household increases, relatively more has to be spent on personal necessities resulting in smaller amounts being available for upgrading the fulfillment of household functions measured by LEVELNOE. The supposition then is that LEVELNOE and the size of the household are inversely related. The data presented in Figure 3, however, do not support this contention. They

(Figure 3 about here)

reveal no consistent pattern. However, the data do demonstrate that USERS have higher scores on LEVELNOE than do either INACCESSIBLES or NON-ADOPTERS irrespective of the size of the household. Furthermore, the difference is substantial in every size of households. Thus, it seems apparent that the size of household does not appreciably affect the level-of-living score of households in the several electric-use categories and does not explain the higher scores of USERS compared to the non-users on this scale.

It is accepted that one of the major factors influencing level of living is educational attainment. The level of living is normally positively associated with education. Our respondents are no exception (Figure 4).

(Figure 4 about here)

The mean LEVELNOE scores for persons in each category of the electric-use characteristic tend to increase with increases in the number of years of schooling completed. The effect of education is especially marked for persons who have completed five or more years of school. When the heads of households with equal years of school were compared, the USERS scored substantially higher on LEVELNOE than did either INACCESSIBLES or NON-ADOPTERS. It can, therefore, be concluded that education does not account for the differences in LEVELNOE found between the persons in the three categories of the electric-use characteristic.

Figure 3

Mean Electricity-free Level of Living Scale (LEVELNOE) Scores for USERS, INACCESSIBLES, NON-ADOPTERS, and Total Population by Number of Persons per Household, Costa Rica

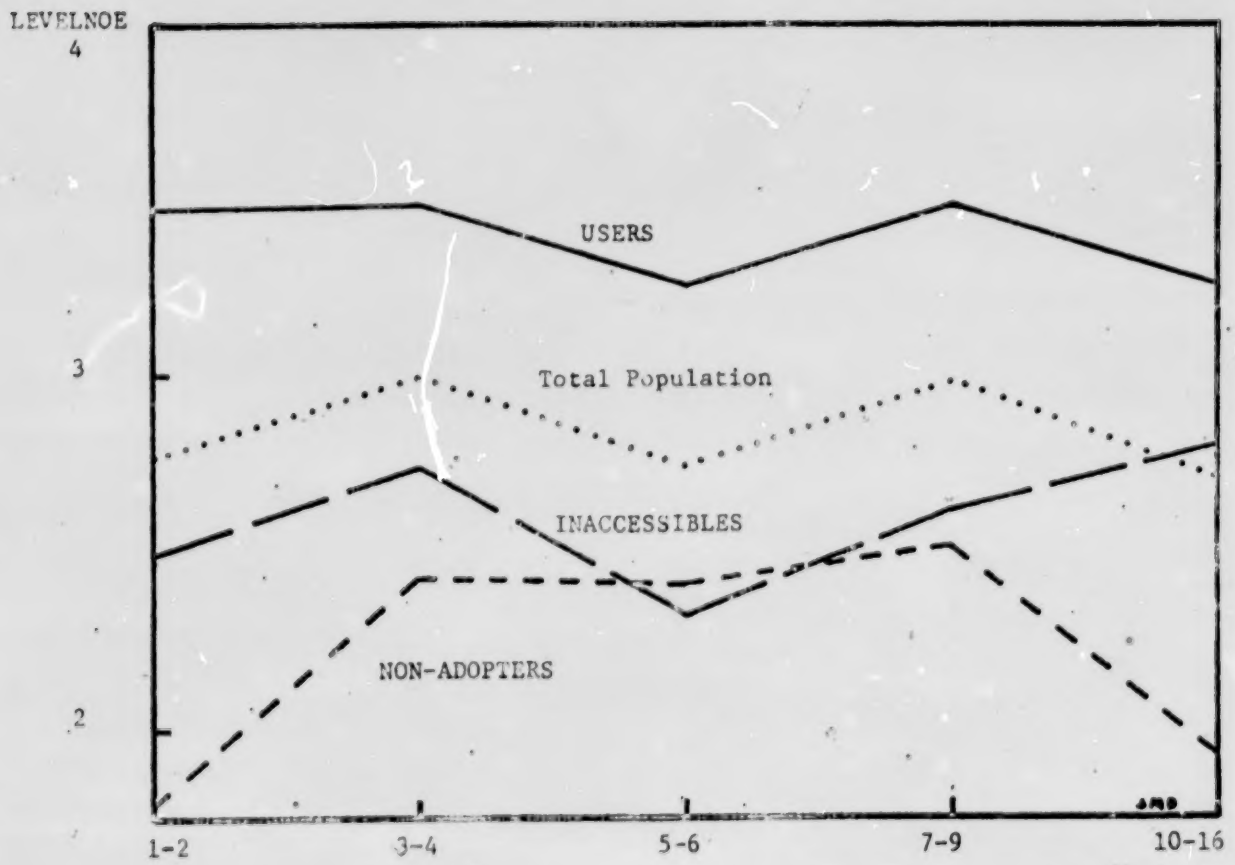
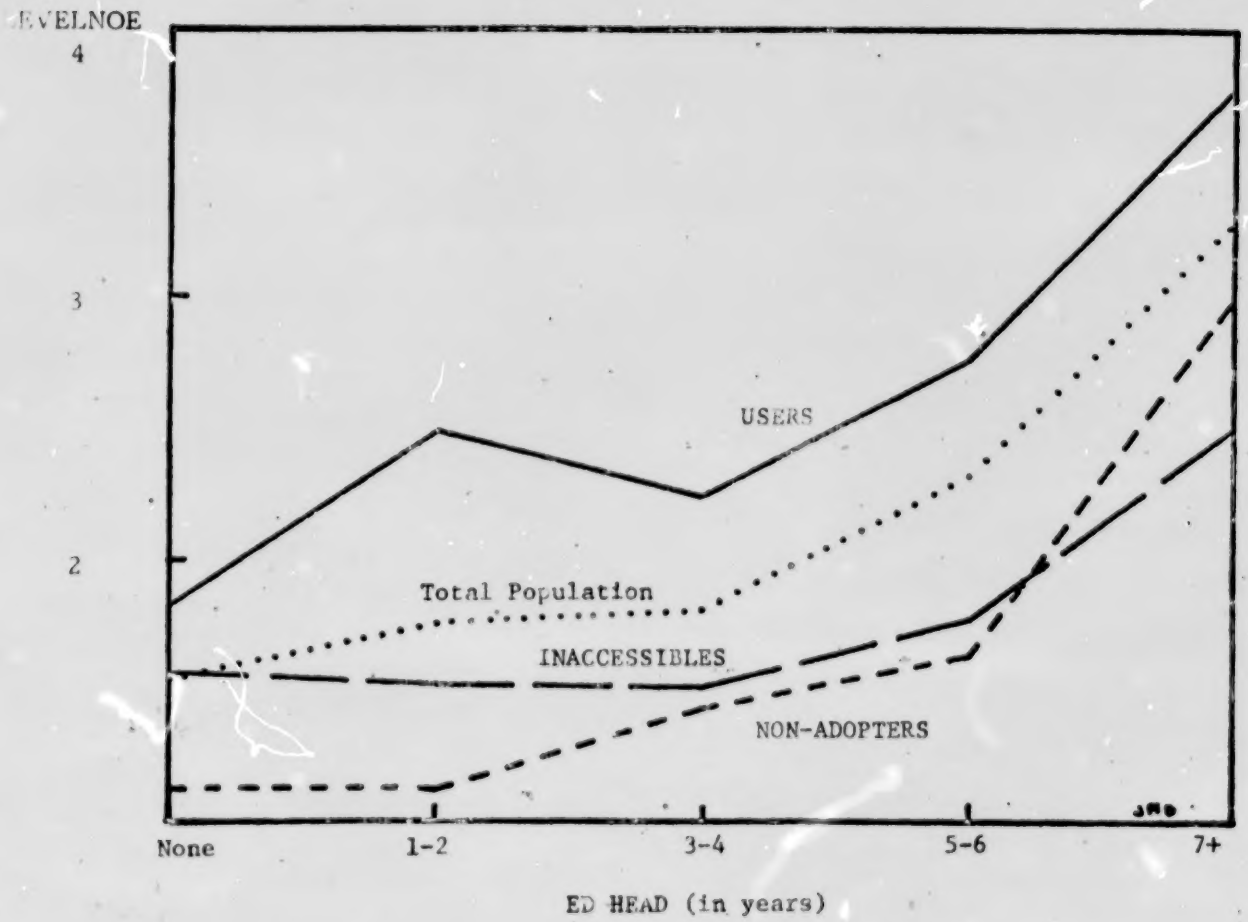


Figure 4

Mean Electricity-free Level of Living Scale (LEVELNOE) Scores for USERS, INACCESSIBLES, NON-ADOPTERS, and Total Population Years of Education of Heads of Households (ED HEAD), Costa Rica



The age of the head of the household (AGE HEAD) was also used as a control variable for the comparison of the LEVELNOE scores of those in the electric-use categories (Figure 5). Except for USERS whose mean

(Figure 5 about here)

LEVELNOE scores tend to drop slightly with advancing age, there is no clear relationship between age and the electricity-free level-of-living scale. Even so, the decline in the LEVELNOE scores of USERS with advancing age is slight. The differential in LEVELNOE between USERS and others persists, however, regardless of the age of the head of the household. Age, therefore, does not explain the higher scores of USERS. INACCESSIBLES once again occupy an intermediate position between USERS and NON-ADOPTERS.

Finally, another possible explanation of differences in LEVELNOE between those in the various electric-use categories is the size of farm. Presumably, income is related to the size of the farm, modified, of course, by the type of enterprise. A positive relationship between the electricity-free level of living scale scores and size of farm (SIZE FARM) is indeed indicated by the data. Mean LEVELNOE scores tend to increase as SIZE FARM increases (Figure 6). The USERS have larger farms than

(Figure 6 about here)

INACCESSIBLES or NON-ADOPTERS. Yet, once again, even when the size of farm is held constant, USERS score higher on LEVELNOE, by a

Figure 5

Mean Electricity-free Level of Living Scale (LEVELNOE) Scores for USERS, INACCESSIBLES, NON-ADOPTERS, and Total Population by Age of Heads of Households (AGE HEAD), Costa Rica

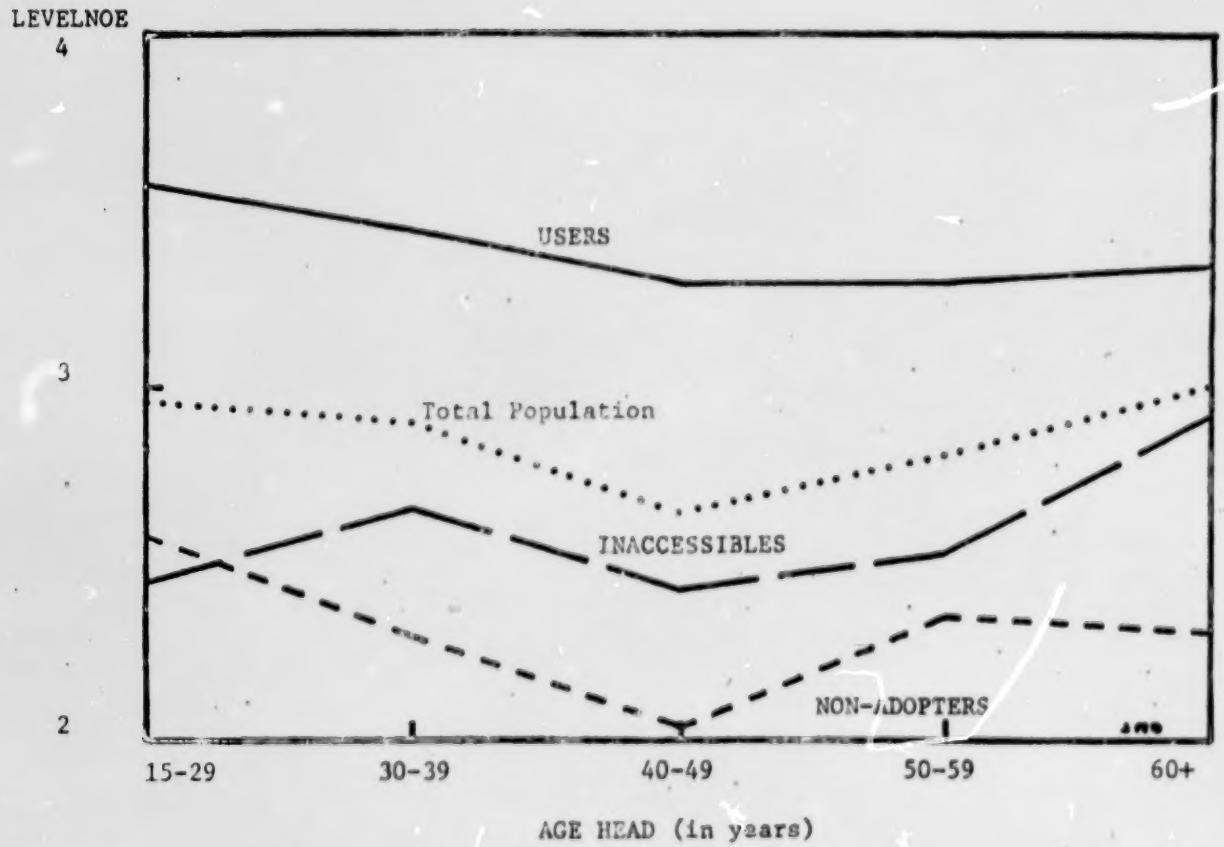
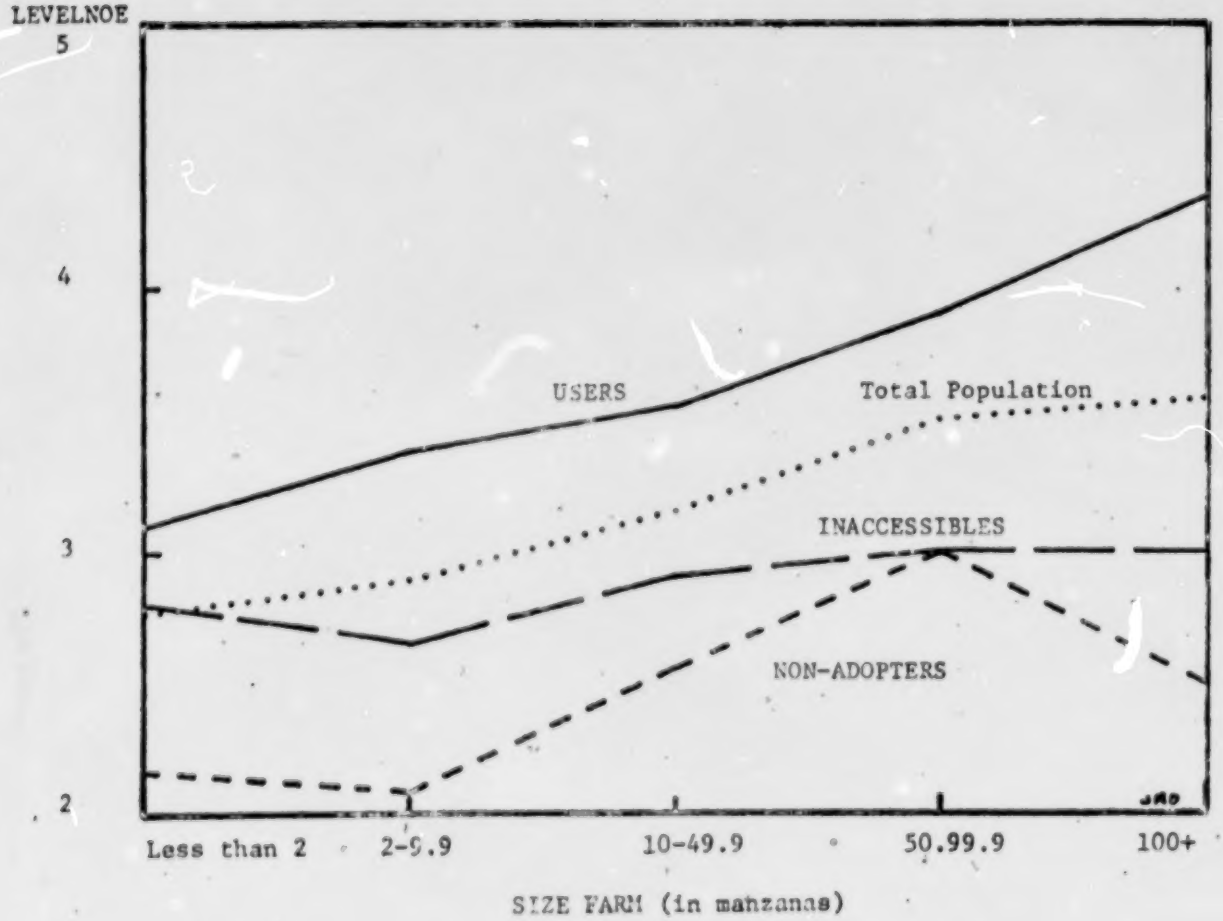


Figure 6

Mean Electricity-free Level of Living Scale (LEVELNOE) Scores for USERS, INACCESSIBLES, NON-ADOPTERS, and Total Population by Size of Farm (SIZE FARM), Costa Rica



substantial margin, than INACCESSIBLES or NON-ADOPTERS. Farm size, then, does not explain the differential in level of living between USERS and others.

DISCUSSION

Users of electricity have been shown to have higher levels of living than non-users of electricity. The introduction of control variables which might be expected to explain the difference in level of living between electricity users and others fail to do so. Although the data do not conclusively prove that electricity use is causal in this relationship, they strongly suggest that it is one of, probably, several causal factors which contribute to the higher level of living of those who use it in the Costa Rica study area. These findings raise questions for further research and have implications for developmental investment decisions. Do other variables not included in the research design explain the difference? If there is indeed a causal relationship, what is the linkage between electricity use and level of living?

Our research in Costa Rica and Colombia has shown that the use of electricity for agricultural production in the areas studied occurs only on large farms of certain types, such as dairy, where a potential for the productive use of electricity exists. Small farm households and non-farm households in the areas studied use electricity for household purposes only and these are limited almost exclusively to lighting, radio listening and ironing. Therefore, rural electrification projects which incur high costs per user accompanied by low consumption levels, when viewed strictly from a cost-benefit approach may well appear to be an unwise invest-

ment. Yet, to the extent to which rural electrification projects stimulate improvements in the level of living, by whatever mechanism, benefits are derived which, although less economically tangible, are no less important from the standpoint of social gains.

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